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FOREST INSECT INVESTIGATIONS

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REPORT TO REGIONAL INVESTIGATIVE COMMITTEE

AND RESEARCH PROGRAM FOR 1934

FOREST INSECT FIELD STATION

BERKELEY, CALIFORNIA

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REPORT TO REGIONAL INVESTIGATIVE COMMITTEE  
AND RESEARCH PROGRAM FOR 1934  
FOREST INSECT FIELD STATION, BERKELEY CALIFORNIA

The year 1932 was an eventful one for forest entomology in Region 5. Developments of the year were influenced to a great extent by outstanding climatic factors that are known to affect forest insect population either directly or indirectly. These were the precipitation of the preceding winter of 1931-32, the heaviest in eight years; a summer of ordinary weather conditions followed by fall drought and warm temperatures extending until early December; and extreme low temperatures in mid-December which killed a high per cent of the bark beetle infestation in northeastern California.

Entomological developments of note were the invasion of ponderosa pine stands by the western pine beetle on the better sites where this infestation had not occurred before, and the building up of losses in sugar pine by the mountain pine beetle to an extent that this now looms up as the major bark beetle problem of the region. Timber losses resulting from the activity of these two Dendroctonus beetles are the heaviest estimated for any season within the past decade, and the interest and concern of conservation agencies and owners brought about active control measures in those areas where the high timber and aesthetic values were at stake. The largest bark beetle control program yet undertaken in the region was initiated and carried out during the winter of 1932-33.

These developments, many of which were unexpected, modified to a considerable extent the research program of the Bureau of Entomology station located at Berkeley. Practically all phases of research were subordinated to the requests by National Parks, National Forests and private owners for recommendations and assistance in the formulation of control plans. Certain studies were continued, however, and to some extent the effort spent on control projects was of advantage, as it gave us a more complete and intimate picture of the infestations than would have been possible if we had depended only upon our sample plot surveys.

## REGIONAL SURVEY

This project was planned primarily to secure basic seasonal information to be used for (1) control recommendations, and (2) a study of the trends and causes of bark beetle infestations. During the past season the first objective has absorbed the greater part of the effort put into the project, as practically all the sample plots that have been set up became involved in epidemics where control work was contemplated by the owners. All the sixteen permanent sample plots were cruised during the year, the majority of them twice. As control recommendations depended largely upon whether the infestation was increasing or decreasing, the second cruise was made in the late fall to determine seasonal tendencies.

Certain sub-phases of the project upon which progress was made are the following:

### a. Composition of Infestation on R.S. Plots

It has been found that the usual basal marking of trees in cruising may at times give a misleading or unsatisfactory idea of the primary infestation. Fortunately the cutting over of some of the R.S. plots by control projects during the winter of 1931-32 made it possible to secure a complete bark surface record of infestation in all overwintering trees. It was found that there is a marked difference in the composition of insect population on the different plots. On the Sierra Ips confusus was a large factor in the 1931 epidemic but was entirely lacking on the Modoc. The infested lengths for D.b. infestation also showed significant differences. Recent records from the Sierra plots show a marked change in the character of 1932 infestation from that of 1931, the primary attack now being one of the pure D.b. type. This change may or may not portend a change in epidemic tendencies.

### b. Plot Inventories

Considerable headway was made during the past winter, but it was not possible to get out a final summary. Growth measurements for all trees in the ten per cent stand cruises have been practically completed. Determination of the net loss in increment for the period of records was started. Some assistance on this phase of the inventories was received from Prof. Barr of the University of California, who directed the work of a graduate student in working out the increment figures for R.S. Plot 1 of the Modoc series. A method for determining increment by age classes in these mature stands was developed. For the six seasons from 1925 to 1930 inclusive this plot shows a net loss in volume of 11.85 per cent, and during none of these years did the increment exceed the amount killed by insects.

#### c. Survival of Top-killed Trees

In 1931 topkilling on the Sierra plots ran as high as 1000 trees to the section. This history of all topkilled trees on the sample plots is being kept in a series of special records based upon hypsometer measurements of length killed. The initial topkilling has been found to be due to Ips and flathead attack, and a certain per cent of these trees become infested later by Dendroctonus beetles. They <sup>do</sup> not become a part of the plot losses, however, until completely killed.

#### d. Climatic Influences

Effects of temperatures upon normal brood development of the western pine beetle were given consideration during the season. Records from the Sierra indicate that at least one extra seasonal generation, the fourth, developed and emerged as a result of the late warm weather in the fall of 1932. These brood records will be continued on the Sierra and Modoc in 1933, with special reference to the effect of bark temperatures upon the number of seasonal generations.

The winter kill of December 1932 and February 1933 has probably had more of an effect upon the D.b. population in this region than any other climatic factor in many years. Mortality counts from a large number of bark sections indicate a kill of from fifty to ninety per cent in northeastern California, but no appreciable kill was found in the Sierra region. It is planned to study the extent and distribution of the winter kill through sample-plot work during the course of the 1933 season.

Correlation of precipitation and growth data with reference to infestation trends is being worked up in connection with the R.S. Plot inventories. But small progress was made on this phase of the study during the past winter.

#### e. Tree Selection by Western Pine Beetle

A recruise of Person's tree selection plot, established in 1926 at Cascadel on the Sierra, was made in 1932 by Struble and a report presented. This shows that in the epidemic of 1931, tree selection by D.b. according to growth rate was a minor factor. Chance selection modified to some extent by site, and initial group selection by Ips, largely determined the location of the large groups of trees infested by D.b.

## RESULTS OF BARK BEETLE CONTROL

Results of control work carried on in the Modoc area during the winter of 1931-32 were analyzed last fall by Salman, and a special report submitted to cooperators. These results show that the work was effective in holding losses to a standstill against the increasing infestations of the 1932 season. On the Badger control area seasonal losses did not increase over those of the preceding year, while on adjacent non-treated areas increases of 100 to 300 per cent developed. Results of the 1931-32 work on the Sierra have not been analyzed, but will become available as the sample plot data are worked up.

The Devil's Garden extermination experiment, instituted to try out the possibility of exterminating the western pine beetle on an isolated area, is now practically completed. Results have shown that continued work for a period of five seasons reduced losses only to a certain low point below which it is not possible to reduce them further; that this intensive work changed the insect population in infested trees from one predominantly D.b. to one predominantly flathead; and that extermination of D.b. is physically impossible under these conditions, although reinfestation can be accounted for by the infestation missed in control work rather than by flight in from distant areas.

## IMPROVEMENT OF CONTROL METHODS

A series of experiments to burn infested ponderosa pine bark with the use of fuel oils so as to prevent fire hazard was carried on in cooperation with the Standard Oil research laboratory, with results that were largely negative. Experiments with toxic penetrative oils to treat bark without burning yielded some promising results when applied to the western pine beetle and the mountain pine beetle in lodgepole pine. Results, however, were not sufficiently consistent to warrant recommendation of this method, and further experiments are contemplated.

Tree medication experiments were carried on during the season with assistance from the University of California. This effort was concentrated upon treatment of white fir to prevent attack by Scolytus. A report submitted by Dr. Gordon gives the results of two seasons' work with pyridine, and shows convincingly that this method is as yet impracticable for actual application in the field. If experimental work is continued it should be concentrated on a study of further chemicals, which can be conducted to the best advantage at the Bureau of Entomology Station at Asheville, N.C.

## INSECTS AFFECTING WHITE FIR

Biological studies of the fir engraver beetle were rounded out during the season. Preparation of a manuscript by Struble was started during the winter but was interrupted by the demands of bark beetle control projects. It is not intended to spend further time on this project other than to check out some of the more obscure points in life histories and to continue records of losses on the sample plots on the Stanislaus.

## MOUNTAIN PINE BEETLE IN SUGAR PINE

This is a new project not previously carried on the station program. The heavy losses in sugar pine which have developed during the past two years have caused this problem to rank as one of the most important for the station area. Very little of the basic entomological work has been done. Life history, seasonal and ecological studies were started last year and will be continued during 1933 with high priority on the station program.

## INTERRELATION - INSECTS AND FIRES

The only work carried on during the year was the re-examination of plots on the Sugar Hill burn on the Modoc. A progress report was submitted by Salman, in which conclusions were drawn and recommendations made as to the types of fire-injured trees which should be cut in salvage operations in this type where it is desired to hold losses to a minimum on burned areas.

## FOREST ENTOMOLOGY - GENERAL

Collections and notes of forest insects within the region have been kept up, and the time of R.L. Furniss was largely devoted to this during the winter. The reference collection was rearranged and transferred to new museum cases, and indexes brought up to date. A work collection containing wood specimens and Riker mounts has been built up and is housed in suitable cabinet space.

## PLANS AND PROJECTS TO BE CARRIED DURING FISCAL YEAR 1934

So far as time is available, the main effort during the season will be concentrated upon a follow-up study of the winter kill in northern California, to determine its extent and effect on the 1933 infestation; upon seasonal records to determine the number of seasonal generations of the western pine beetle and their relation to cumulative bark and air temperatures; and upon seasonal history and other biological studies of the mountain pine beetle in sugar pine. This program may be modified according to the priority that will have to be given to demands for control surveys and the Conservation Corps labor relief activities.

Two projects carried on last year's program--Reduction of Loss Through Marking (R.S. ~~Plot~~ P1-2) and Interrelation of Insects and Slash (R.S.P1-3)--have been merged for the present into the Regional Survey Project. A final examination was made of the Timber Mountain experimental thinning plots on the Modoc by Salman and a report submitted; but results were considered unsatisfactory due to uncontrolled wood-cutting operations and intensive sheep grazing on the area. Some laboratory work upon attraction studies with the western pine beetle (R.S.P1-9) is in progress by Gordon, but no report has been prepared. Nutritional studies of the western pine beetle (R.S.P1-10) has been dropped.

The attached project sheets represent practically all projects upon which active work is contemplated by the Berkeley Station. Of those without symbol designations, one is new and the others were not included in the Regional Investigative Report of April 18, 1932.

## Project RS-P1-1 - Results of Bark Beetle Control

Scope To measure the effects of present control methods as applied on going projects by Federal and private owners, including the western pine beetle, mountain pine beetle, flathead and Ips infestations. This includes studies of the more favorable seasons for the work and the length of time during which results are effective.

### Status

This project has been under way for a number of years; but under the present project set-up results obtained are to a considerable extent incidental to data secured by the Regional Survey. Several large projects, notably those on the Sierra Forest and Yosemite Park, undertaken within the region during the past two years, will provide a fairly good basis for this study when results become available.

### Results of the past year

Results obtained on two small projects--Echo Lake and Baldwin Estate on the Eldorado--show fairly effective control of the mountain pine beetle. Analyzed results of the Devil's Garden Extermination Experiment indicate that extermination of the western pine beetle is impracticable. Work on the Badger Springs Project in 1931-32 has shown the effectiveness of control in holding down losses against an increasing infestation tendency, although actual losses were not reduced below those of the preceding year.

### Plans for Fiscal Year 1934

Effort will be concentrated upon a study of the results of the Sierra, Yosemite, General Grant and Sequoia Projects. It is expected that results on the Modoc and Shasta Projects will be obscured by results of winter kill, but some study of combined control and weather effects will be made.

### Assignments

Salman, Struble, Miller.

## Project RS-Pi-6 - Interrelation of Insects and Fires

### Scope

To study the influence of fire injury upon subsequent bark beetle infestations, the susceptibility of fire-injured trees to attack, and the possibility of restricting losses subsequent to the fire through salvage operations in surviving trees.

### Status

Project has been carried by station since 1924. One large study, that of the Northfork burn of 1924, was completed in 1928. Sample plot studies on the Sugar Hill fire on the Modoc have been continued since 1929.

### Results of Last Year

An examination of the Sugar Hill plots was made by Salman in November and the results were analyzed in a progress report. In general, susceptibility of trees suffering from foliage injury alone varies with the amount of defoliation, with a maximum loss on this area of about 20 per cent of the stand in Class V, the most seriously injured included in the study. Susceptibility of trees suffering from cambium injury in addition to foliage injury is markedly greater than that of trees suffering from foliage injury alone. Losses in Class V trees suffering from both types of injury reached nearly three-fourths of the total number of trees studied in that class.

Salvage operations will depend entirely upon the conditions existing on any given fire. The results of this study, however, indicate that it is advisable to salvage all cambium-injured trees in Class IV (more than 50 per cent of crown defoliated) and all trees in Class V (more than 75 per cent of crown defoliated), regardless of cambium injury.

### Plans for Fiscal Year 1934

One more re-examination of Sugar Hill plots is contemplated. Some further studies on Northfork burn will be made if time is available.

### Assignments

Salman, Miller.

## Project RS-P1-7 - Regional Survey of Forest Insect Infestations

### Scope

1. To obtain information annually regarding the character, intensity and trends of bark beetle infestations, for use in both the formulation of control measures and research;
2. To correlate such trends with the physical factors of climate, soil, topography, biotic factors and the activities of man, in order to assign causes for the fluctuating intensity of infestations;
3. To obtain information concerning the effects of infestations on timber stands, particularly as regards susceptibility of stands to bark beetle attack, changes in stand composition and the effects upon reproduction and other vegetative growth.

### Status

This was set up as a distinct project in 1931 with detailed plans as to objectives and methods. Since then 16 permanent sample plots have been established, about equally divided between east-side and west-side ponderosa pine types. These have been marked and tagged, ten per cent stand cruises made, growth measurements taken and compilation of inventories started. Records of insect losses to date have been compiled, some of these extending back for eleven years where former sample sections used in control surveys were selected for sample plots.

### Results During Past Year

All permanent plots were cruised, some of them twice, during the season, in order to determine seasonal tendencies as a basis for control recommendations. Composition of the infestation that developed during 1931 and 1932 has been analyzed on plots included in control projects. A record of topkilled trees has been started and causes studied. Records to correlate the number of seasonal generations with temperatures were started on the Sierra plots. A field study and analysis of winter kill on the Badger area of the Modoc, due to low temperatures in December 1932, was made and cancellation of further control work recommended. A study of comparative increment and timber losses on RS Plot 1 for the period 1925-1930 shows a net loss over increment of 11.85% for the six-year period. General surveys and cruises of areas outside the permanent sample plots were made, and on the basis of all available data an estimate of timber losses totaling 1,500 million board feet in 1932 was made for the region.

Project RS-P1-7, concluded

Plans for Fiscal Year 1934

The recruise of all plots will again be made to determine 1933 seasonal losses; records of brood development and seasonal generations to be kept in the Sierra and Modoc areas along with records of bark temperatures; effects of winter kill in northern California and its influence on the 1933 infestation to be studied; plot inventories and correlation of climatic factors to be continued.

Assignments

Salman, Struble, Miller, Field Assistants

## Project RS-Pi-9 - Attraction Studies with the Western Pine Beetle

### Scope

Determination of repellents and attractants as preliminary to the development of better control methods.

### Status

Project was started in 1928 with preliminary work by Mirov, but without any promising leads except that a positive attraction to fermented phloem was demonstrated. Laboratory work was resumed by Gordon during the winter of 1931-32 and equipment was developed for rapid testing of the responses of the adult beetles to various materials.

### Results for Past Year

An olfactometer was developed by which the responses of the beetles to the vapors of chemicals and organic substances can be very definitely measured. The perfected model of this apparatus is now in use at the Berkeley Laboratory. With it the results obtained by Mirov have been substantiated. It has been further shown that as the fermentation of phloem advances toward the acid stage this material becomes highly repellent. A large series of chemicals have been tested, some of which show definite repellent or attractive properties. A report giving results of these experiments and a paper upon the olfactometer will be prepared by Gordon.

### Plans for Fiscal Year 1934

Indefinite--dependent upon cooperation by the University of California and whether or not Gordon is assigned to the tree medication experiments at Asheville, N.C.

### Assignment

Gordon.

## Project - - Improvement of Control Methods

### Scope

To carry on experiments with the object of improving or modifying present control methods so as to increase their effectiveness and lower costs, and to develop methods that are new in principle and technique.

### Status

Project has been carried on for many years by this station and has brought about the development of new methods, such as solar heat control and various modifications of the burning and peeling methods.

### Results of Past Year

Experiments carried on in cooperation with the Standard Oil Research Laboratory have shown that burning of infested yellow pine bark with fuel oils is impracticable, but that the use of toxic penetrative oils without burning may be effective in killing western pine beetle broods under special conditions. Experiments to immunize white fir against the attacks of Scolytus ventralis by the injection of pyridine into the sap stream were without success.

### Plans for Fiscal Year 1934

Further experiments with toxic penetrative oils will be continued on a small scale on the Modoc.

### Assignment

Salman.

## Project - - Insects Affecting White Fir

### Scope

To determine the economic importance and life histories of insects responsible for the injury and complete killing of Abies concolor, with special reference to the loss and amount of defect occurring in trees left on cutover areas.

### Status

Project has been in progress since 1929. Sample plots have been established in virgin and cutover lands on the Stanislaus Forest for which continuing records are being kept. Scolytus ventralis has been determined as the primary cause of losses and its life and seasonal history have been studied. Association with a cambium-killing fungus was determined as an essential factor in the infestation of this insect.

### Results of Past Year

Studies of the associated fungus in cooperation with the Office of Forest Pathology were carried to the point of determining the beetle as a definite carrier of the fungus. Life and seasonal history of Scolytus was practically completed and a manuscript on this insect started.

### Plans for Fiscal Year 1934

Limited work on seasonal history and continuation of sample plot records.

### Assignment

Struble.

## Project - - Mountain Pine Beetle in Sugar Pine

### Scope

To determine the economic importance of the mountain pine beetle in sugar pine, the insects associated with it, its seasonal history in the Sierra Nevada region and its general ecology.

### Status

This is a new project in the station set-up, although some information of value has been collected in connection with previous work. Three of the Regional Survey plots include sugar pine type, and on these loss records are already under way.

### Results of Past Year

A study of the topkilling of sugar pine was started on Regional Survey plots, and records of the seasonal history of the mountain pine beetle were carried on through part of the 1932 season.

### Plans for Fiscal Year 1934

Further plots will be established as time permits, preferably selected so as to fit into the Regional Survey system. Studies of the progressive killing of sugar pines from the top down and biological studies of the mountain pine beetle will be continued.

### Assignment

Struble and Field Assistants.

## Project - - Forest Entomology, General

### Scope

To collect and study all species of insects injurious to forests in the region, to work out their proper determination and to assemble information regarding them through a system of indexed notes, together with information regarding their host relations and natural enemies.

### Status

A continuing project, carried on incidental to other work. A large collection of both insects and examples of their work has been assembled by workers at the station during the past twenty years. This is now very well organized and in suitable cabinet space.

### Results of Last Year

A regrouping of the collection and its installation in dermestid-proof museum cases was completed. All material has been indexed.

### Plans for Fiscal Year 1934

Work to be continued as time permits.

### Assignment

All Station personnel.